

Comparing the functional outcome of Anterior Cruciate Ligament (ACL) reconstruction using an autologus Bone Patellar Tendon Bone (BPTB) graft and an autologus Quadriceps Tendon Bone (QTB) graft using modified transtibial technique.

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Abstract

The primary function of the ACL is to prevent anterior translation of the tibia relative to the femur. Other functions of the ACL include resisting internal rotation of the tibia and varus or valgus stress of the tibia in the presence of collateral ligament injury.¹ Rupture of ACL is one of the most common ligamentous injuries of the knee with an incidence of 35 out of 100,000 population

worldwide.² The incidence of reconstruction of the anterior cruciate ligament has been reported as high as 75,000–100,000 per year in the USA.³ Worldwide, it is most commonly caused by sports injuries, however in India, it is mainly caused by road traffic accidents.⁴ Techniques of ACL reconstruction have evolved tremendously which include surgical technique, tunnel

placement, timing of surgery and postoperative Rehabilitation protocols.⁷

The autologous grafts most frequently used for anterior cruciate ligament (ACL) reconstruction are the central one-third of the bone-patellar tendon-bone (BPTB) and the hamstring (semitendinosus and gracilis, STG).⁸

The quadriceps tendon autograft (QTA) is becoming a popular graft for primary and revision ACL reconstruction.¹³ The QTA is easy to harvest,^{14,15} can be obtained with¹⁴ or without¹³ a patellar bone block, is adequately thick to accommodate an expanded tibial tunnel in revision operations, produces fewer donor site problems than if the patellar tendon is harvested,¹⁵⁻¹⁸ has excellent mechanical characteristics,^{13,15,17,18} is attributed with a larger cross-section area when compared to the patellar tendon,^{14,16,19-21} and induces minimal quadriceps inhibition after the quadriceps harvest.²⁰

Main purpose of our study is to To compare the functional outcome of Anterior Cruciate Ligament (ACL) reconstruction using an autologous Bone Patellar Tendon Bone (BPTB) graft and an autologous Quadriceps Tendon Bone (QTB) graft using modified transtibial technique.

Keywords: ACL, Quadriceps tendon autograft, bone-patellar tendon-bone (BPTB)

Introduction

Anterior cruciate ligament (ACL) injury is very frequent, not only in professional athletes but also—increasingly often— in people who practice sports regularly. Conservative treatment usually fails to eliminate recurrent symptoms during the return to activities. Additionally, with subsequent instability episodes, patients may show an accelerated onset of degenerative joint changes and meniscal injuries. ACL reconstruction

aims to eliminate symptoms and prevent such degenerative joint changes.⁵ ACL reconstruction restores the stability of the knee joint and protects the menisci and joint surfaces from further damage,⁶ and prevents worsening of existing chondral lesions as well as occurrence of newer lesions. Reconstruction of the ACL may also alter the incidence of osteoarthritis in the longer term.⁶ Also, ACL does not have the potential to adequately heal by itself when torn, therefore surgical ACL reconstruction is generally the treatment of choice.² Even as graft choices and fixation devices and methods continue to evolve and improve, several principles remain integral to successful ACL reconstruction. Bone-patellar tendon-bone (BPTB), quadriceps tendon autograft (QTA), modified transtibial technique, are few of the methods used for reconstruction in our study. A modified transtibial technique,²⁵ that consists of simple man oeuvres during the femoral tunnel guide insertion that enable anatomic positioning of the tunnels. The technique also allows sufficient tunnel length to be obtained for fixation, and the tunnel widening is minimal.

Materials and methods

Study Site: Department of Orthopaedics, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh, India.

Study Design: A prospective, single blind, randomized comparative Study.

Study Period: 18/06/21 to 17/12/22 - 18months.

Study Population: ACL injured patients who requires surgery will be selected based on the inclusion criteria and will be divided into GROUP- 1 for Quadriceps Tendon Bone (QTB) graft & GROUP- 2 for Bone Patellar Tendon Bone (BPTB) graft each comprising of 25 patients.

Selection criteria

Inclusion criteria

1. Young Adults (20 – 45 yrs).
2. Patients with chronic ACL Injury.
3. Patients with ACL injury associated with Meniscal Injuries.
4. Patients with ACL injury associated with Chondral Defects up to Grade3.

Exclusion criteria

1. Patients with acutely injured Knee.
2. Patients with history of previous Knee surgeries.
3. Patients with infection of the Knee.
4. Patients with degenerative joint disease of the Knee.
5. Patients with multiligamentous knee instability.
6. Patients with stiff Knee with deformity.
7. Patients with associated metabolic disorders.
8. Patients with associated inflammatory disorders.

Results

This study group includes 50 patients who underwent Arthroscopic ACL reconstruction, with QTB autograft in 25 patients and with BPTB autograft in 25 patients using Modified Transtibial Technique with a minimum follow-up period of 1 year.

Demographics

Age Distribution: Our study included only young active patients between the age groups of 20 to 45yrs, who were actively involved in high demanding activities.

Table 1: Comparison of Age between the study groups.

Randomization	N	Mean	SD	Mean Difference (95% CI)	t	df	p-value
QTB	25	30.24	6.91	-0.64 (-4.65, 3.37)	-0.32	48	0.75(NS)
BPTB	25	30.88	7.19				

Independent sample t test

*p<0.05 Statistically Significant,

p>0.05 Not Significant, NS

Sex Distribution

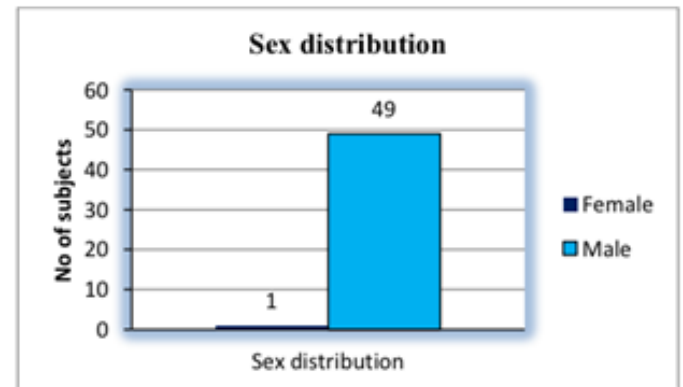
All patients in our study were Males except only one Female, who were actively involved in high demanding works. There is no statistically significant difference between study groups.

with a p-value of 1.00.

Table 2: Comparison of Sex distribution between the study groups.

		Randomization		Total	Chi square test	
		QTB	BPTB		Chi square value	p-value
Sex	F	0	1	1	-	1.00(NS)*
		0.0%	4.0%	2.0%		
	M	25	24	49		
		100.0%	96.0%	98.0%		

Graph 1:

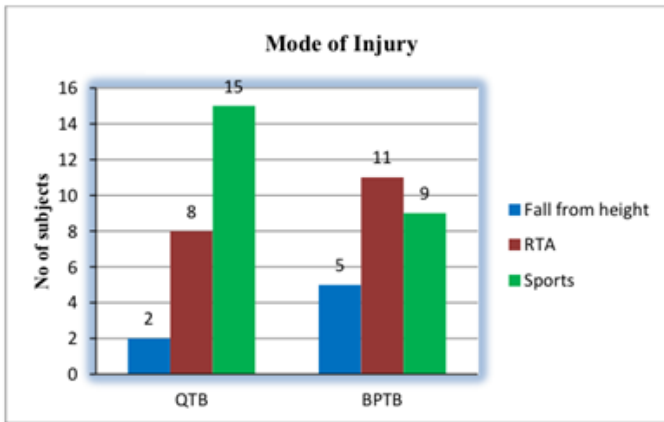


Mode of injury:

Table 3: Comparison of mode of injury between the study groups.

		Randomization		Total	Chi square test	
		QTB	BPTB		Chi square value	p-value
Mode of Injury	Fall from height	2	5	7	-	0.21(NS)*
		8.0%	20.0%	14.0%		
	RTA	8	11	19		
		32.0%	44.0%	38.0%		
	Sports	15	9	24		
		60.0%	36.0%	48.0%		

Pie diagram 1: Mode of injury



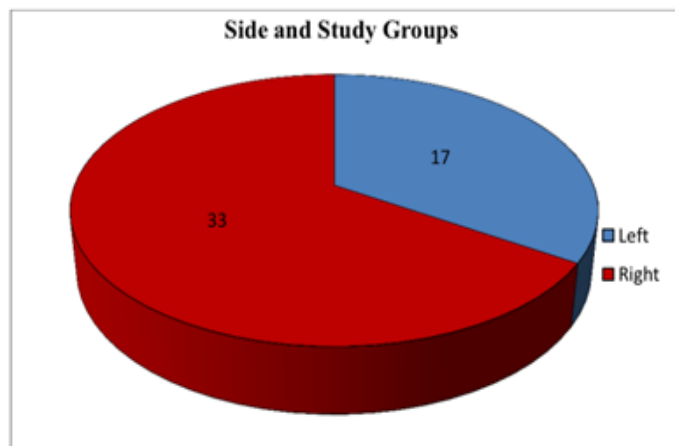
Graph 2: Mode of injury

In our study, most of the patients sustained ACL tear due to sporting activities, with 24 patients (48%), followed by Road traffic accidents, with 19 patients (38%). There is no statistically significant difference between study groups, with a p-value of 0.21.

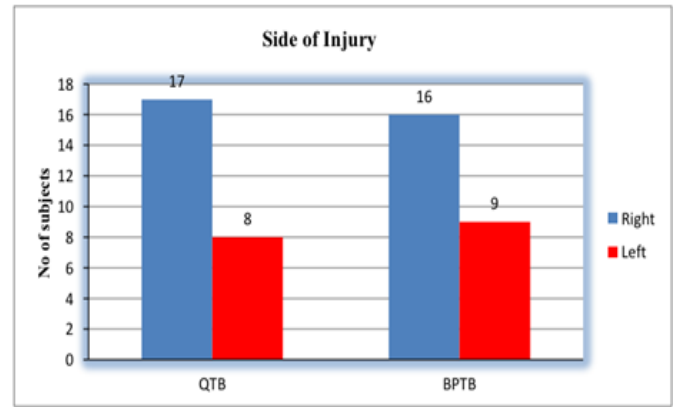
Side of ACL injury

Table 4: Comparison of side of injury between the study groups.

		Randomization		Total	Chi square test	
		QTB	BPTB		Chi square value	p-value
Side	Left	8	9	17	0.09	0.77(NS)
		32.0%	36.0%	34.0%		
	Right	17	16	33		
		68.0%	64.0%	66.0%		



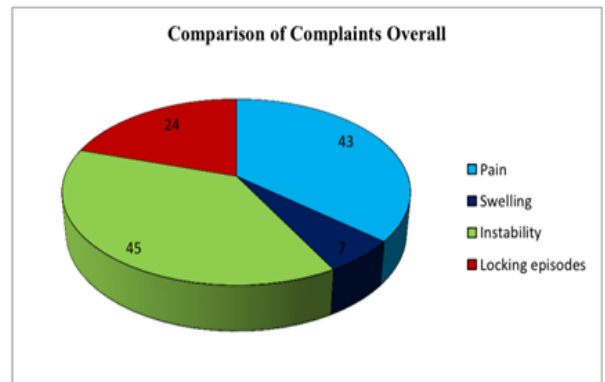
Pie diagram 2: Side of injury



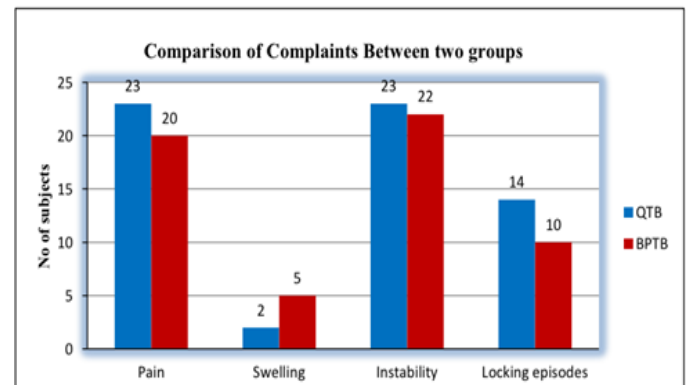
Out of 25 patients in QTB group, 17 patients (68%) were right side and 8 patients (32%) were left side injured. In BPTB group, 16 patients (64%) were right side and 9 patients (36%) were left side injured. Most of our patients (66%) were found to be injured in their right knee.

There is no statistically significant difference between study groups, with a p-value of 0.77.

Clinical Presentation:

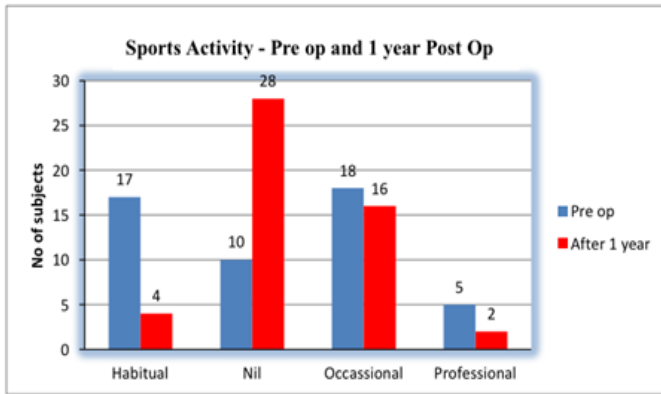


Pie diagram 3: Comparison of Complaints Overall

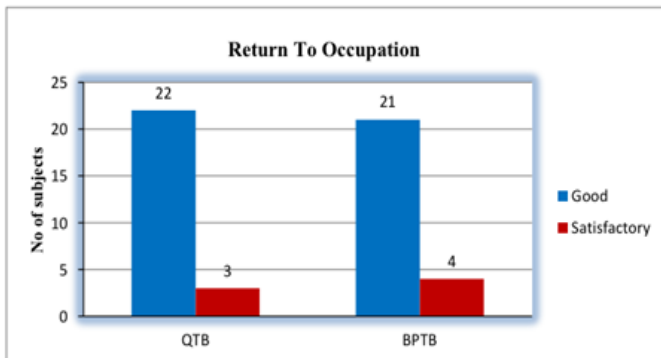


At the time of presentation, 45 patients (90%) came with complaints of instability, 43 patients (86%) with pain, locking episodes in 24 patients (48%) and swelling in 7 patients (14%).

Return to Sports and Occupation:



Graph 15: Comparison of Sports Activity at Pre op and 1 year Post Op



Graph 16: Comparison of Return to Occupation between QTB and BPTB groups.

Majority of the patients who were involved in high sporting activities successfully returned to their near pre-Injury status.

All patients were functionally capable of performing their ADL & Occupational works effectively.

Observations

Mode of Injury

Our study shows that majority of the patients (24 patients, 48%) sustained ACL injury as a result of Sporting activities. Owing to the rural circumstances of

our location, the proportion of professional Sports persons to that of patients playing recreational sports is very low.

Other causes of ACL injury observed were either road traffic accidents, mainly involving two-wheeler motorbikes (19 patients, 38%) or fall from height (7 patients, 14%).

ACL tear is one of the extensively studied Sports injuries, yet without any clear-cut absolute and definitive guidelines in its management. The controversy for managing this injury now centres more on the choice of graft selection, method of fixation and technique used for reconstruction rather than the need for a surgery. Though ACL Reconstruction by BPTB autograft is gold standard treatment modality, there is a decline in use because of graft site morbidity. ACL reconstruction using QTB autograft is gaining popularity because of less graft site morbidity when compared to BPTB autograft and also as a autograft choice for revision ACL reconstruction. Various tunnelling techniques being used for reconstruction like Anatomical, Transtibial and Modified transtibial. The main objective of this study is to evaluate whether the functional outcomes when ACL Reconstruction done using QTB autograft are comparable with the ACL reconstruction done using BPTB autograft.

Similar studies

In 2017, Lund et al.⁵⁶ conducted a prospective, randomized comparative study of 51 patients who underwent ACL reconstruction using BPTB autografts and QTB autografts.

In 2008, Kim et al.⁴⁹ conducted a retrospective study of 48 patients who underwent ACL reconstruction using BPTB and QTB autografts and functional outcome evaluated at 24 months post operatively.

In 2008, Han H et al.¹⁶ conducted a non-randomized retrospective comparative study of 144 patients. Of which 72 patients who underwent unilateral anterior cruciate ligament reconstruction using bone-patellar tendon-bone between 1994 and 2001 and matched for age and gender with 72 patients who underwent anterior cruciate ligament reconstruction using quadriceps tendon-patellar bone. All patients were followed up for more than 2 years.

In 2007, Gorschewsky et al.⁴⁸ conducted a retrospective comparative study. A total of 260 patients with ACL ruptures were operated between 1995 and 2000. 124 received a BQT- autograft, including 8 revisions; 136 patients received a BPTB autograft, exclusively primary interventions. The results were evaluated using the IKDC-, Noyes- and Lysholm-Scores. It was possible to re-evaluate 194 patients after a minimum follow-up period of 2 years.

In our study, we evaluated 50 patients with Chronic ACL tear with a Mean age being 30.24 in QTB group and 30.88 in Modified BPTB group. In Lund et al.⁵⁶ study mean age being 30 +/- 9 in QTB group, 31 +/- 8 in BPTB group. In Kim et al.⁴⁹ study mean age being 27.1 +/- 9.9 in QTB group, 30.2 +/- 8.3 in BPTB group.

In our study 49 males and only one female were included. Lund et al.⁵⁶ study included 21 males, 4 females in BPTB group, 21 males and 5 females in QTB group. Kim et al.⁴⁹ study included 21 males and 6 females in BPTB group, 18 males and 3 females were included in QTB group.

In Han H et al.¹⁶ study 72 patients were included in each group with 4 females and 68 males. Females were observed to be less injured with respect to ACL tear when compared to Males.

Conclusion

In Literature, most common mode of ACL injury was noted to be Sports injuries, while in our study, Road traffic Accidents also contribute to significant numbers.

Patients with ACL tear due to Sports injuries were noted to have more associated intra articular ligament injuries.

Patients who presented late had significant Quadriceps wasting and had associated Intra articular pathologies.

Patients with associated Intra articular pathologies showed lower mean Functional scores in the initial follow-ups but were comparable at 1-year follow-up, except IKDC scores in QTB group with chondral injury showed statistically significant results at 6 weeks, 3months and 1 year follow up.

Good compliance with the Accelerated ACL Rehab protocol showed good outcomes of the surgery with respect to their progressive increase in Functional scores at every follow-up.

Proper Bone tunnel placement in Femur and Tibia were found to be playing a key role in achieving excellent results. In spite of having Grade 1 Laxity in few patients postoperatively, the functional outcomes were noted to be satisfactory.

Performed under Ideal conditions, ACL Reconstruction with Modified Transtibial technique is a safe & effective technique.

ACL Reconstruction using QTB autograft gave equally good clinical results in terms of stability and the functional scores when compared to BPTB autograft group, but with less graft morbidity like anterior kneeling pain and hypoesthesia.

Graft harvesting in both BPTB and QTB group is technically challenging, however the chances of accidentally breaching suprapatellar pouch is very high in QTB group.

Although QTB autograft has a single bone plug, it provides a strong and firm graft which facilitates reasonably good fixation using a soft interference screw. Use of transparent sleeve and soft interference screw during femoral interference screw application, avoids graft attrition.

References

1. Beasley L, Weiland D, Vidal A, Chhabra A, Herzka A, Feng M et al. Anterior cruciate ligament reconstruction: A literature review of the anatomy, biomechanics, surgical considerations, and clinical outcomes. *Operative Techniques in Orthopaedics*. 2005;15(1):5- 19.
2. Muller B, Hofbauer M, Wongcharoenwatana J, Fu F. Indications and contraindications for double-bundle ACL reconstruction. *International Orthopaedics*. 2012;37(2):239-246.
3. Garrick J. Reconstruction of the Anterior Cruciate Ligament. *The Journal of Bone and Joint Surgery-American Volume*. 2000;82(8):1202.
4. Pulate A, Jadhav A, Kakatkar S. Comparison of Functional Outcomes Following Arthroscopic Anterior Cruciate Reconstruction Using Trans-Tibial Technique and Trans- Portal Technique. *J Maha Ortho Assoc*. 2012;7(2):15-17.
5. Rodriguez-Merch an E. Evidence-Based ACL Reconstruction. [Internet]. *Europepmc.org*. 2018 [cited 14 June 2018]. Available from:<http://europepmc.org/articles/PMC4322130/>
6. Louboutin H, DE barge R, Richou J, Selmi T, Donell S, Neyret P et al. Osteoarthritis in patients with anterior cruciate ligament rupture: A review of risk factors. *The Knee*. 2009;16(4):239-244.
7. Suresh anSiv Ananthan, Eugene Sherry, Patrick Warnke, Mark D Miller. *Text book of Orthopaedics and Trauma: Diagnosis and management of ligamentous injuries of the knee*. 10th ed. London: Hodder Arnold;2012.
8. Laxdal G, Sernert N, Ejerhed L, Karlsson J, Kartus J. A prospective comparison of bone- patellar tendon-bone and hamstring tendon grafts for anterior cruciate ligament reconstruction in male patients. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2006;15(2):115-125.
9. Laxdal G, Kartus J, Hansson L, Heidvall M, Ejerhed L, Karlsson J. A prospective randomized comparison of bone-patellar tendon-bone and hamstring grafts for anterior cruciate ligament reconstruction. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2005;21(1):34-42.98
10. Kartus J, Movin T, Karlsson J. Donor-site morbidity and anterior knee problems after anterior cruciate ligament reconstruction using autografts. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2001;17(9):971-980.
11. Laxdal G, Kartus J, Ejerhed L, Sernert N, Magnusson L, Faxén E et al. Outcome and Risk Factors After Anterior Cruciate Ligament Reconstruction: A Follow-up Study of 948 Patients. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2005;21(8):958-964.
12. Laxdal G, Kartus J, Eriksson B, Faxen E, Sernert N, Karlsson J. Biodegradable and Metallic Interference Screws in Anterior Cruciate Ligament Reconstruction Surgery Using Hamstring Tendon Grafts. *The American Journal of Sports Medicine*. 2006;34(10):1574- 1580.
13. Adams D, Mazzocca A, Fulkerson J. Residual Strength of the Quadriceps Versus Patellar Tendon After Harvesting a Central Free Tendon Graft. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2006;22(1):76-79.

14. Fulkerson J, Lange land R. An alternative cruciate reconstruction graft: The central quadriceps tendon. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 1995;11(2):252-254.
15. Noronha J. Reconstruction of the anterior cruciate ligament with quadriceps tendon. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2002;18(7):1-5.
16. Han H, Seong S, Lee S, Lee M. Anterior Cruciate Ligament Reconstruction. *Clinical Orthopaedics and Related Research*. 2008;466(1):198-204.
17. Pigozzi F, Di Salvo V, Parisi A. Isokinetic evaluation of anterior cruciate ligament reconstruction: quadriceps tendon versus patellar tendon. *J Sports Med Phys Fitness*. 2004;44(3):288-293.
18. Kim D, Kim J, You J, Kim S, Kim H. Arthroscopic anterior cruciate ligament reconstruction with quadriceps tendon composite autograft. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 2001;17(5):546-550.
19. Blauth W. 2-Strip substitution-plasty of the anterior cruciate ligament with the quadriceps tendon. *Unfallheilkunde*. 1984;87(2):45-51. German. 99
20. Morgan C, Kalman V, Grawl D. Definitive landmarks for reproducible tibial tunnel placement in anterior cruciate ligament reconstruction. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*. 1995;11(3):275-288.
21. Staubli H, Schatzmann L, Brunner P, Rin can L, Nolte L. Quadriceps tendon and patellar ligament: Cry sectional anatomy and structural properties in young adults. *Knee Surgery, Sports Traumatology, Arthroscopy*. 1996;4(2):100-110.
22. Macaulay A, Perfetti D, Levine W. Anterior Cruciate Ligament Graft Choices. *Sports Health: A Multi-disciplinary Approach*. 2011;4(1):63-68.
23. Kwak Y, Lee S, Lee M, Han H. Anterior cruciate ligament reconstruction with quadriceps tendon-patellar bone allograft: matched case control study. *BMC Musculoskeletal Disorders*. 2018;19(1):45.
24. Xerogeanes J, Mitchell P, Karasev P, Kolesov I, Romine S. Anatomic and Morphological Evaluation of the Quadriceps Tendon Using 3-Dimensional Magnetic Resonance Imaging Reconstruction. *The American Journal of Sports Medicine*. 2013;41(10):2392-2399.
25. Lee J, Lee S, Seong S, Lee M. Anatomic Single-Bundle ACL Reconstruction Is Possible with Use of the Modified Transtibial Technique. *The Journal of Bone and Joint Surgery- American Volume*. 2014;96(8):664-672.
26. Koukoubis TD, Glisson RR, Bolognesi M, Vail TP. Dimensions of the intercondylar notch of the knee. *Am J Knee Surg*. 1997; 10:83-87
27. Kieffer J, Galen, May M. Galen, on the Usefulness of the Parts of the Body. With an Introduction and Commentary. *The Classical World*. 1969;62(9):357.
28. Davarinos N, O'Neill B, Curtin W. A Brief History of Anterior Cruciate Ligament Reconstruction. *Advances in Orthopedic Surgery*. 2014; 2014:1-6.
29. Robson AM. VI. Ruptured crucial ligaments and their repair by the operation. *Annals of surgery*. 1903;37(5):716.
30. Groves EH. Operation for the repair of the crucial ligaments. *The Lancet*. 1917;190(4914):674-676.